Reassessing Vulnerability to Macroeconomic Volatility: a nonstationary panel approach

Mickaël Clévenot, Marie Silvère Mbome

CEPN Centre d'économie de l'Université Paris Nord CNRS UMR n° 7234

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The article examines the sensibility of economic growth to macroeconomic volatility, and the impact of financial development on volatility for a sample of 85 countries and OECD countries over two periods covering 1975 to 2006. In that purpose, we implented nonstationary panel techniques that account for cross-section dependence issue.
We checked for the existence of a cointegrating relationship between variables. Finally we estimated such relationship using the Augmented mean group (AMG) method.

We confirm the Ramey (1995) findings of the negative correlation between output growth and volatility for the full sample and the subsample of OECD countries, however our results are stronger for OECD countries. Moreover accounting for the interaction between volatility and financial development leads to stronger results. Indeed the interaction seems to impact positively on growth, but at the same times, it seems to magnify vulnerability to shocks.

Résumé

L'objet principal de ce travail consiste à mesurer la sensibilité de la croissance à la volatilité macroéconomique sur un panel de 85 pays OCDE et Non- OCDE sur la période 1975 2006. Nous mobilisons les techniques des panels non-stationnaires et de la cointégration de panel (méthode AMG) afin d'identifier avec précision la vulnérabilité de la croissance à la volatilité macroéconomique.

Avec un cadre méthodologue plus solide, nous retrouvons les résultats établis par Ramey & Ramey (1995). Ainsi, l'ensemble de l'échantillon décrit une relation négative entre la volatilité et la croissance. Les résultats sont plus nets pour les pays de l'OCDE. La prise en compte des interactions conduit à nuancer les résultats. En effet, l'interaction entre développement financier et volatilité semble jouer un rôle positif sur la croissance. Mais de l'autre côté, la sensibilité de la croissance à la volatilité est accrue.

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Mickaël Clévenot

Marie Silvere Mbome

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The article examines the sensibility of economic growth to macroeconomic volatility, and the impact of financial development on volatility for a sample of 85 countries and OECD countries over two periods covering 1975 to 2006. In that purpose, we implented nonstationary panel techniques that account for cross-section dependence issue. We checked for the existence of a cointegrating relationship between variables. Finally we estimated such relationship using the Augmented mean group (AMG)method . We confirm the Ramey and Ramey (1995) findings of the negative correlation betweeen output growth and volatility for the full sample and the subsample of OECD countries, however our results are stronger for OECD countries. Moreover it seems that high level of financial development hampers growth. We also find that although reducing output volatility, financial development seems to magnify vulnerability to shocks.

Résumé

L'objet principal de ce travail consiste à vérifier les effets de la volatilité macroéconomique sur la croissance sur plusieurs groupes de pays par régions et par niveau de revenu. La plupart du temps cette relation est significativement négative. De plus, les faits stylisés semblent indiquer que la volatilité pourrait être expliquée par le phénomène de syndrome hollandais, une mauvaise spécialisation et/ou une insertion internationale inadéquate en raison de maintien d'un régime de change inadapté.

Keywords : Macroeconomic volatility, growth, cross-section dependence, unit root test

Code JEL : O43, F54, E32

Introduction

Generally, the literature on growth considers volatility as a concern. It is particularly true in keynesian and post-keynesian view. Keynes (2006) underlines the role of the state as stabilizer of anticipations. In the *régulatinnionste* view [Aglietta (1976)] the role of institutions is to stabilise the growth regime. Macroeconomic volatility is not only a source of business uncertainty but also a major cause of low economic growth. The volatility reduces the temporal horizon of the agents who cannot make expectations, this in turn lowers investments, increases savings and brakes growth. Output volatility affects present and future consumption because it decreases growth. Indeed the macroeconomic instability hurts investments and tends to impact negatively on the agents confidence. On the other hand, the volatility can represent a kind of economic dynamism emphasizing innovations which give rise to important transformations that originate instability. This is a Shumpeterian view. Innovations lead to the destabilization of the old economical sectors by the emergence of news ones based on new products or new process. This induces the destruction of part of the economy which in turn produces volatility, but the substitution of old sectors by new ones more productive leads to growth. Authors as (Aghion and Banerjee (2005), Kormendi and Meguire (1985)), and Black (September 1987) explain that such positive effect of volatility on growth occurs through the financial translation of this innovations. However, volatility seems to impact differently on countries growth according to the level of economic development (Koren and Tenreyro (2005)).

Overall, the view that macroeconomic volatility lowers growth is widely accepted in the contemporaneous literature, few of it describes a theoretical positive effect based on shumpeterian creative destruction or finance. However, the empirical evidence on the latter are weak, and sometimes it seems that there is a litle confusion between micro and macroeconomic level.

In our study we try to assess the vulnerabitlity of economic growth to macroeoconomic volatility through the time. In that purpose, we use a panel data of 85 countries and a subsample of 24 OECD countries over the period 1975-2006. We implement the second generation of tests that account for cross-section dependence to deal with problems arising from nonstationary data as misleading inference or inconsistent estmators. In that aim we apply unit root tests proposed by Pesaran (2007) and Bai and Ng (2004) to check for cross-section correlation. Then we test for cointegration between the variables using

the test proposed by Westerlund (2007). Finally we estimate the model by using the AMG estimator proposed by (eberhardt, 2013). The results obtained are in line with the findings of Ramey and Ramey (1995) confirming the detrimental effect of volatility on growth even in OECD countries which is in contrast with some thesis on the positive effects of volatility in such countries, however our results are in line with the more recent literature on financial development. This relationship is still robust after controlling for financial development. Finally when controlling for the effect of financial deepening, we find that excessive financial intermediation is detrimental for growth. Indeed more finance means, more indebtness and this also means higher risk. Higher risk in turn leads to higher volatility, thus to higher sensibility to macroeconomic fluctuations and to lower growth. Our analysis rely on Ramey and Ramey (1995) and in (Aghion and Banerjee, 2005), but it different in the sense that, it uses relative standard deviation rather than standard deviation as volatility's measure. Moreover we account for cross-section dependence. Our main results could be summarized in different points:

- Our panel is not stationary
- The panel is cointegrated
- The macroeconomic volatility impacts negatively on growth
- financial development seems to have negative effects on growth
- It seems that the sensibility to macroeconomic volatility rised over the time

The remainder of the paper is structured as follows:the first section provides a brief overview of the literature. The second section presents the data and methodology. The third part presents the estimation results and the conclusion.

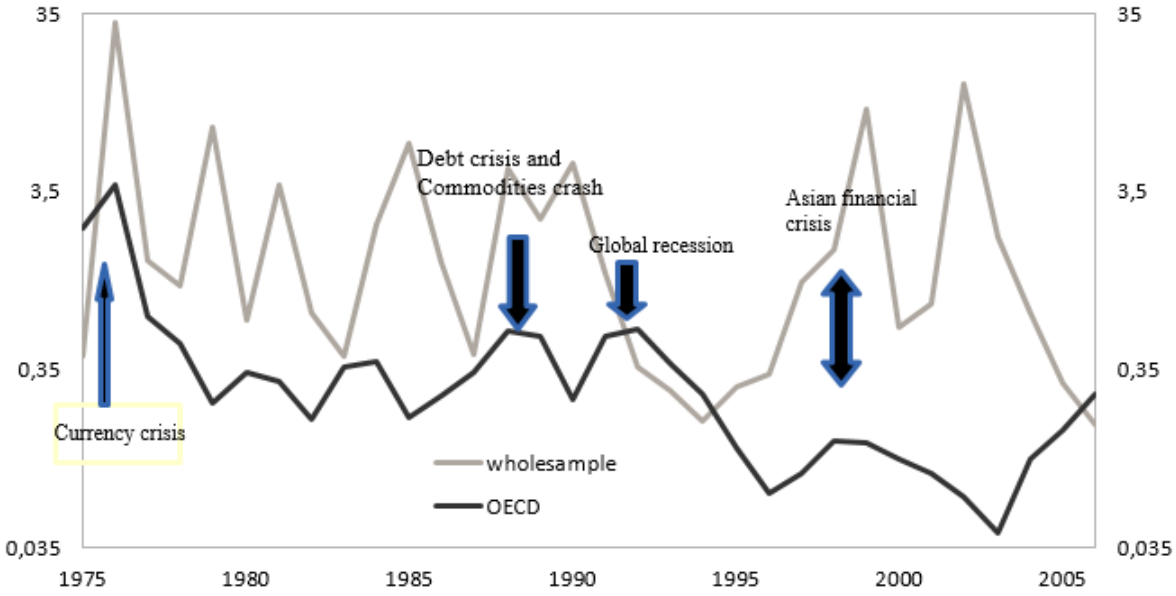
1 Literature Review

There is enough empirical evidence on the negative relationship between economic fluctuations and growth Ramey and Ramey (1995) Badinger (2010) Krishna and Levchenko (2009). The first influential empirical work was pioneered by Ramey and Ramey (1995) which found a negative correlation between volatility and growth. But this result has been criticized by several studies among them Dawson and Stephenson (1997) who argue that the (Ramey and Ramey, 1995) results may have been caused by measurement error in cross-country data. Thus the negative relationship is not a genuine casual relation-

ship, rather an artefact of cross-country data quality variation. There exist three kinds of analysis on this argument: at sectoral level, cross-regional and cross-country studies. Several empirical papers attempt to investigate the nature of the relationship between volatility and growth with results more or less ambiguous. There are four scenarios on the growth-volatility relationship subdivided into positive, negative, mixed or nought relationship. Such distinction leads also to controversial results. Advanced countries hold countercyclical policies and a system of insurance covering a large part of the population and the economic activity.

Figure 1: Link between income level and macroeconomic volatility

(Logarithmic scale)



Author's calculations

The figure plots volatility for advanced countries and the global volatility. There is a clear evidence of ouput volatility decline from the early 1980s. The decline has been sharper in advanced countries than in the rest of the world. However output volatility remained low in OECD countries, despite some episodes of volatility of abnormally high volatility in the mid 1980s, the end of 1990s and the early 2000's . The periods of high volatility could be explained by the different crisis which hit the economies at different periods of time. Finally, we observe two periods of higher volatility in advanced countries: 1993-1994 and 2003-2006. Such decline in output volatility is the so-called "great mod-

eration" phenomenon, some studies explain that it derives partly from changes in shocks and better economic policies.

1.1 Volatility & growth, a complex relationship

In the literature, some authors did not find any kind of relationship between volatility and growth. Indeed Dawson and Stephenson (1997), applying Ramey and Ramey (1995) to data from 48 contiguous USA over the years 1970-1988, found no evidence of the relationship between volatility and growth. Moreover, they suggest that the Ramey and Ramey (1995) results may have been caused by measurement error in cross-country data. Thus the negative relationship is not a genuine casual relationship, rather an artefact of cross-country data quality variation. But this study can tell little on the nature of the relationship since it based only on USA data. In a similar vein, in order to test the Black's (1987) hypothesis, Grier and Perry (2000) using the GARCH method on a sample of USA data from 1948-1996, find no evidence on the positive relationship between volatility and growth. Caporale and McKiernan (1997), used an ARCH-M model based on Black's (1987) hypothesis. They found evidence for a positive link between output growth and volatility for the U.S. on a sample over period from 1870 to 1993. The above studies was made mostly on advanced countries, so the results seem to confirm the theory on the positive link between volatility and growth in advanced countries. The last scenario entails studies suggesting a mixed volatility-growth relationship. Imbs (2002) uses disaggregated data in order to decompose growth into intensive and extensive margin in order to show that the same dataset used by Ramey and Ramey (1995) can be exploited to obtain both negative and positive correlation. Indeed he sustains that "the negative link between aggregate growth and volatility masks a positive one at the purely disaggregated level". Moreover Imbs (2002) explains the discrepancy in the results as arising from cross-country heterogeneity in the sectoral composition of aggregate output. Posch and Walde (2009), argue that the sign of the relationship depends on the purpose of taxes on wealth, if used to promote R& D the relationship is positive. In contrast when the taxes are used to foster physical capital investment, then the negative link can occur. Furthermore they suggest that the Ramey and Ramey (1995) results are biased because of the omitted variables, thus by adding further control variables to the conditional variance equation the bias will be reduced. Blackburn and Pelloni (2001) rested on a non-stationary time

series of stochastic growth allowing for learning-by-doing. They concluded that long-run growth is negatively linked to the volatility in the presence of nominal shocks, but positively related in the case of predominant real shocks. Furthermore they explain that the relationship is negative in the absence of nominal rigidities and either positive or negative in the presence of such rigidities. Another study by Blackburn and Galindev (2003) suggest that there is no fundamental reason for assuming that the relationship between volatility and growth should assume one particular sign under one particular growth mechanism. They conclude that the correlation between growth and volatility may either be positive or negative according to whether technological change is driven by internal learning (purposeful learning) or external learning (serendipitous learning), respectively.

1.2 Positive relationship

The positive effects of macroeconomic volatility could derive from a questioning of established positions (Rent-seeking), institutional changes which lead to the improvement of long-term growth. Financial liberalization which often leads to short-term destabilization could fall into this category, and a large number of reforms which aim to liberalize the organisation of the economy. Therefore, the instability is the transitory cost to pay for an increase of a long-term growth.

The empirical evidence on the positive link between volatility and growth dated back to Kormendi and Meguire (1985), they examine the cross-country relationship between the mean growth and the variables suggested in Levine and Renelt (1992). Furthermore they include the standard deviation of growth in order to test the (Black, September 1987) hypothesis, they used the same procedure as Ramey and Ramey (1995) where they allow volatility to differ across countries but not across the time. They find a positive relationship between real fluctuations and growth confirming the Black's hypothesis. Dejuan and Gurr (2004) realizes a test on cross-section and panel data estimation for a sample of 10 canadian provinces over a period from 1961-2000 and find a weak positive association between both variables. The financial theory applied to a macroeocnomic analysis could also explain the simultaneous presence of a macroeconomic volatility and growth. According to (Black, September 1987), investment in riskier technologies are made if and only if the expected return technologies is large enough to compensate the extra risk.

These investments could lead, in the case of success, to the innovation and to the questioning of the established positions. Finance and innovations associate to increase growth and volatility simultaneously, by accelerating the destructive-creation process. Indeed it rests on shumpeterian view which states that fluctuations in economic activity help to reconstruct the economic system in a more efficient way: the so-called "creative destruction". The dynamism of Darwinian selection allows to keep only efficient agents. But such microeconomic theories neglect macroeconomic consequences of instability. Further, the empirical tests appear to be negative and/or non significant while the authors maintain their conclusions on the theoretically positive role of the volatility on growth. But in most cases, estimations conclude a negative relationship or non significant relationship for advanced countries.

1.3 Negative relationship

The neoclassical school of though ignores the uncertainty and the complexity of the capital factor. In the controversy of the two Cambridge on the production function, the critics of J. Robinson on the Solow model were on the possibility of a technical continuum with capital considered as marmalade. Conversely, physical capital has adjustment costs. As we approach the technical reality of capital, more we observe its specificity within each unit of production. Capital, will mostly needs a time to adapt to firm's needs. These adjustment costs impact heavily on the capital cost and question the continuity of the production function. Under uncertainty, these adjustment costs create irreversibility which could be at the origin of macroeconomic volatility. Such insights have been incorporated in the neokeynesian framework. Behind the position of negative effects there is the theory of irreversibility of investments under uncertainty. Pindyck (1991) & Bernanke (1980) argue that irreversibilities of investments, which make capital reallocation inefficiently expensive once installed lead to higher volatility and so to more uncertainty about long-run inflation, implying lower investment and subsequent growth. In a similar vein (Stiglitz, 1993) shows that economic fluctuations negatively impact on future productivity because long-run losses are far more significant than any temporary gains.

The empirical work on growth begins with Ramey and Ramey (1995), using a panel data of 92 countries and a subset of 24 OECD countries over a period from 1960-1985 and from 1950 to 1988 respectively. They detect a negative and strong relationship between

volatility and growth. Henry & Olekans (2002), Tochkov and Tochkov (2010), Aghion and Banerjee (2005) and Badinger (2010) among others also find a negative correlation between Growth and volatility. Additionally, Asteriou and Price (2005), studying a cross-country analysis for a sample of 59 industrialised and developing countries, they find output fluctuations to be inimical to both investment and growth. Hnatkovska and Loayza (2004) investigate the cross-country relationship between macroeconomic volatility and long-run growth, they find growth to be negatively correlated to volatility. Another study on the volatility-growth tradeoff has been realised by (Martin and Rogers, 1995). They argue that when the learning by doing is at the origin of growth, the long-run growth rate should be negatively related to business cycle fluctuations if human capital is increasing and concave in the cyclical component of production. They test such hypothesis through a cross-country analysis of a sample of 24 OECD countries and 90 European regions for the period, they confirm the hypothesis only for OECD countries and for the european regions but not for developing countries. Furthermore they explain that growth is driven by learning by doing only at relatively high levels of development. (Kneller and Young, 2001),separate the effects of volatility into short-run and long-run effects. By doing so they used panel estimation and time varying volatility, secondly they constructed annual observations of volatility for a pooled mean group dynamic panel regression. They find that volatility is detrimental for growth for a sample of OECD countries. Moreover, they surmise that the opposing results in the previous literature occurred because they do not allow for a time variation of volatility within national economies.

Overall, the general consensus is that growth is significantly and negatively correlated to growth. The differences are made when the studies subdivide the volatility into different components or when the study account for the mechanism at the origin of growth.

2 DATA & Methodology

The previous literature on real volatility and growth does not consider the cross-section dependence issue in panel data. The first generation of tests assumed a cross-section independence that is there is no role for common shocks (Bai et al., 2009). Indeed cross-section correlation could arise from omitted data, spatial effects or as a result of interaction within socioeconomic networks. Thus, leading out the crosssection dependence could lead

to serious size of distortions and power loss. The second generation of tests overcome such limit through common factors. In our analysis we implement the panel unit root test of (Bai and Ng, 2004) and Pesaran (2007). The first proposes the PANIC (Panel Analysis of non-stationarity in idiosyncratic and common component). Such approach allows for nonstationarity driven either by the common factor or by the idiosyncratic component or by both. The Pesaran (2007) also allows for cross-sectional dependence, the error term is assumed to have an unobserved one-common-factor structure accounting for cross-sectional correlation and an idiosyncratic component. Also the first generation of cointegration test (Pedroni,1999) assumed cross-section independence so in our article we implement the coinegration test proposed by Westerlund (2007). Our analysis is based on a sample of 85 countries and a subsample of 24 countries over 1975-2006. The sample is then splitted into two subperiods wiht a length of 16 years each. Data for empirical analysis was extracted from the most updated Heston et al. (2012) database. Data on financial development are from the World Bank.

2.1 Empirical methodology

Firstly we follow (Ramey and Ramey, 1995) and hinge on Levine and Renelt (1992) for the choice of dependent and explanatory variables. Data on real Gdp, average investment and average population growth are from Heston et al. (2012) database, while the data on average of secondary schooling are from Barro& Lee 2010. Data on financial development are from the world bank database. We model the output growth-volatility tradeoff as follows:

$$\Delta Y_{it} = \alpha_{it} + \beta\sigma_{it} + \theta X_{it} + \varepsilon_{it} \tag{1}$$

$$\varepsilon_{it} \sim (0, \sigma_i^2)$$

where, X_{it} is the vector of control variables.

ΔY_i is the average annual growth in per capita GDP α_i is the standard deviation of annual growth in per capita GDP divided by GDP growth.

The dependent variable is the real GDP growth. The control variables are: the average investment in percentage of GDP, the log of initial income, population growth rate and the log of average years of secondary schooling. Relative to the seminal contribution by

(Ramey and Ramey, 1995) we assume that the standard deviation varies across years and across individuals. Indeed, by assuming a constant volatility across time Ramey and Ramey (1995) neglect the fact that at a given moment of time the economy could be subject to particular events (civil war, natural disasters, crisis etc...) leading to higher or lower volatility. The previous studies on the volatility-output growth relationship use the standard deviation of real gdp growth as indicator of economic volatility. This equivalent to ignore growth differences between countries. Moreover using the standard deviation as a measure of volatilty is endogenous to real gdp, thus ignoring this issue could lead to distortions. To overcome such drawback we divide standard deviation by the absolute mean growth rate of gdp. Finally we test the impact of financial develoment on growth through as in Aghion and Banerjee (2005). Thus we have the following regression:

$$\Delta Y_{it} = \alpha_{i0} + \alpha_{i1} vol_{it} + \alpha_{i2} Y_{it} + \alpha_{i3} FD_{it} + \alpha_3 FD_{it} * vol_{it} + \theta_i X_{it} + u_{it} \qquad (2)$$

Financial development is measured by the ratio of private credit to GDP. We used this measure because it excludes credit granted to the public sector and funds coming from central or development banks. The next sections are dedicated to the presentation of the empirical results, including panel estimates of the link between output growth and volatility.

3 Results: volatility is clearly an issue

3.1 Panel unit root, stationarity testing and cross-section dependence

We use panel unit root tests that account for cross-section dependence in the form of common factor. First, we compute the test proposed by Pesaran(2007) to assess whether the panel time series are stationary. Pesaran(2007) Proposes a cross-sectional augmented Dickey-Fuller (CADF) test where the standard Dickey-fuller regressions are augmented with cross-sectional averages of lagged levels and first differences of the individual series. He also considers a cross-sectional augmented IPS (CIPS) test, which is a simple average of the individuals CADF-tests proposes a cross-sectional augmented Dickey-Fuller (CADF) test where the standard Dickey-fuller regressions are augmented with cross-sectional averages of lagged levels and first differences of the individual series. The results of CIPS

Table 1: Cross-section Dependence

Variables	CIPS without trend	with trend
Output growth	-2.732** (0.01)	-3.062** (0.01)
Volatility	-2.661** (0.01)	-2.792** (0.01)
Average years of Schooling	-1.522 (0.89)	-1.3690 (0.99)
Average investments	-1.717 (0.565)	-2.154 (0.85)
Population growth	-2.158** (0.015)	-2.3560 0.395
Private credit	-1.8177 (0.38)	-2.196 (0.78)

p-vaue in parentheses *** p<0.01, ** p<0.05, * p<0.1

(2007) are displayed in table 1, which shows that the null hypothesis is strongly rejected in both cases (with and without trend) for output growth, volatility and population growth, however the null hypothesis can not be rejected for the other variables. Which leads us to conclude for a non stationarity of the panel.

(Bai and Ng, 2004) aproach accounts for cross sectional dependance given by the cross-cointegration relationship among variables. To estimate the idiosyncratic component they implement the ADF test for individual unit roots and the Choi's type (Z_e^c) and Fisher type tests for the panel unit root hypothesis (P_e, which has standard normal distribution. They also use the mQ_c and mQ_f to account for additional serial correlation. The estmation of the number of factors is determined through the BIC criterion as suggested in Bai & Ng(2002), with a maximum of six common factors. The results are given in Table 2. All the variables have five common trends. Moreover, the number of common factors is equal to the number of trends, which implies that the nonstationarity is more due to common factors than idiosyncratic components.

Table 2: PANIC statistics

Variables	Criterion	Estimated	Idiosyncratic shocks		Common factors		
		common factors	Z_e^c	P_e	ADF trends	MQ_c	MQ_f
Output growth	BIC3	5	7.430 *** (0.000)	307*** (0.000)	-	5	5
Volatility	BIC3	5	13.185*** (0.000)	413.119*** (0.000)	-	5	5
Average years of schooling	BIC3	5	-0.2795 (0.610)	164.847 (0.597)	-	5	5
Investments	BIC3	5	1.7073** (0.044)	201.481** (0.049)	-	5	5
Population growth	BIC3	5	1.391 * (0.082)	195.657* (0.0865)	-	5	5
Private credit	BIC3	5	0.468 (0.32)	178.638 (0.31)	-	5	5

p-value in parentheses *** p<0.01, ** p<0.05, * p<0.1

3.2 Panel Cointegration

The presence of common sources of nonstationarity leads to the concept of cointegration. As aforementioned the first generation of cointegration test assumed cross-section independence. In our analysis we adopt the Westerlund (2007) cointegration test. Westerlund (2007) proposes four new panel statistics: the group mean and statistics the panel statistics . The first group entails two tests statistics (G_a and G_t) that test the null hypothesis of no cointegration for all cross sectional units against the alternative that at least one cross-sectional unit is cointegrated. The rejection of the null should be taken as evidence of cointegration for at least one cross-sectional units. The second group of tests (P_a and P_t) pool information regarding th error correction along the cross-section dimension in order to test the null of no cointgeration under the alternative of cointegration for the whole panel. Thus the rejection of the null implies cointegration for the panel as a whole. The results of the cointegration test are summarized in table 3:

Table 3: Panel Cointegration test

Output growth	Volatility			average years of schooling			Investments Investments			Population growth			Private credit		
	value	Z_v	P_v	value	Z_v	P_v	value	Z_v	P_v	value	Z_v	P_v	value	Z_v	P_v
G_t	-2.97	-7.01	0.00	-2.89	-6.12	0.00	-2.64	-3.24	0.00	-2.87	-5.92	0.00	-3.07	-8.23	0.000
G_a	-14.087	-3.035	0.00	-15.102	-4.441	0.00	-13.241	-1.862	0.03	-14.234	-3.238	0.00	-15.138	-4.492	0.000
P_t	-21.055	-1.836	0.03	-26.706	-8.418	0.00	-28.670	-10.706	0.00	-29.295	-11.43	0.00	-29.252	-11.383	0.000
P_a	-10.902	-3.007	0.00	-14.375	-8.368	0.00	-14.516	-8.585	0.00	-16.102	-11.033	0.000	-14.146	-8.014	0.000

Authors calculations

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

All statistics lead to the rejection of the null hypothesis, so the panel is strongly cointegrated, in other words there exist a long run relationship between output growth and the other variables of the panel.

3.2.1 Estimation of the output growth-volatility link

Our cointegration test evidentiates the existence of long run relationshiop between the dependent variable and the other variables. Which lead us to adopt an estimation which accounts for cross-section dependence in the data. The FMOLS proposed by Kao Chang (2000) and the Dynamic ordinary Least squares (DOLS) estimator of Philips Hansen (1990) and stock and Watson (1993), despite estimating the long-run parameters and correct for autocorrelation and endogeneity, they assume cross-section independence. The estimation proposed by eberhardt (2013) considers this issue by allowing for cross-section dependence. The results of the estimations are summarized in table 4 and table 5:

Table 4: Panel estimations

	(1) 1975-2006	(2) 1975-2006	(3) 1975-1990	(4) 1975-1990	(5) 1991-2006	(6) 1991-2006
VARIABLES	full	full	full	full	full	full
Volatility	-0.001***	-0.004**	-0.001*	-0.003*	-0.003***	-0.034***
	(0.000)	(0.002)	(0.000)	(0.002)	(0.001)	(0.013)
Investment	0.073***	0.057**	0.003	0.097***	0.115***	0.0922*
	(0.023)	(0.022)	(0.033)	(0.022)	(0.028)	(0.049)
Initial	0.0149	0.015	0.015	-0.001	-0.033*	-0.014
Income	(0.01)	(0.011)	(0.018)	(0.009)	(0.018)	(0.025)
Population	-0.8***	-0.414*	-0.388	-0.210	-0.892**	0.321
growth	(0.303)	(0.244)	(0.303)	(0.225)	(0.368)	(1.331)
Education	0.017***	0.012**	0.024***	0.004	0.007	0.0024
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.020)
Private		-0.032***		-0.038***		0.035
credit		(0.012)		(0.010)		(0.039)
Private credit*		0.007		0.007		-0.009
volatility		(0.006)		(0.005)		(0.088)
Constant	-0.08	-0.116	-0.132	0.0177	0.274*	0.107
	(0.086)	(0.092)	(0.145)	(0.073)	(0.156)	(0.213)
Observations	2,720	2,720	2,720	2,720	1,360	1,360
Number of countries	85	85	85	85	85	85

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table 5: Panel estimations

	(1) 1975-2006	(2) 1975-2006	(3) 1975-1990	(4) 1975-1990	(5) 1991-2006	(6) 1991-2006
VARIABLES	oecd	oecd	oecd	oecd	oecd	oecd
Volatility	-0.005***	-0.011**	-0.013***	-0.012***	-0.01***	-0.021**
	(0.0015)	(0.005)	(0.004)	(0.004	(0.003)	(0.01)
Investment	0.169***	0.155***	0.178***	0.177***	0.153***	0.114**
	(0.0501)	(0.0468)	(0.053)	(0.0444)	(0.0445)	(0.0489)
Initial	-0.0433***	-0.00468	-0.038**	-0.0201	-0.0240	-0.02
Income	(0.0107)	(0.0227)	(0.018)	(0.0157)	(0.0382)	(0028)
Population	-0.311	-0.244	-0.356	-0.257	-1.582	-1.328*
growth	(0.349)	(0.283)	(0.458)	(0.331)	(1.152)	(0.752)
Education	0.0194***	0.021***	0.019*	0.009	-0.031	-0.034
	(0.005)	(0.0065)	(0.011)	(0.006)	(0.022)	(0.031)
Private		-0.043***		-0.043***		0.189
credit		(0.014)		(0.011)		(0.185)
Private credit*		0.017**		0.015***		0.022
volatility		(0.007)		(0.005)		(0.048)
Constant	0.427***	0.0661	0.382***	0.204	0.277	0.244
	(0.104)	(0.212)	(0.154)	(0.144)	(0.377)	(0.280)
Observations	768	768	768	768	384	384
Number of countries	24	24	24	24	24	24

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

column 1 of table 4 and 5 display the results of Ramey and Ramey (1995) regression over 1975-2006 for the full sample and OECD countries. We confirm their findings of strong negative relationship between economic growth and output volatility for the whole sample and the subsample of OECD countries. The convergence hypothesis is verified only for developed countries. The average investment ratio is significant only for both the whole sample and the for the subsample of advanced countries. Also the variable education has the right sign that it is positively correlated to economic growth. Concerning the population growth, the Malthusian effect is confirmed for the full sample but not for the sample of OECD countries, where the population growth seems to have no impact on growth. Volatility impacts negatively and strongly on growth for the whole sample and OECD countries. In column 2 we account for the interaction between private credit and volatility, we find that while the interaction between private credit and volatility influence positively the economic growth of advanced countries, it seems to have no effect on economic growth as a whole. In other words financial development reduces output volatility only in advanced countries. However, the private credit seems to impacts negatively and significantly on output growth. We can explain our results following Arcand et al. (2012) findings. Indeed they find that the marginal effects of finance development on growth becomes negative when credit to private sector is between 80-100Next we do the same regressions by focusing on two subperiods: 1975-1990 and 1991-2006. we find similar results for the first subperiod, however the impact of volatility on growth is negative but non significant for the full sample. In the last subperiods the sensibility to macroeconomic fluctuations increases either for the full sample of countries or the subsample of oecd countries, besides private credit has no effect on economic growth. In the second subperiod, the we observe an increase in the sensibility to macroeconomic fluctuations for both sample and subsample of countries. Moreover, the financial development seems do not have any effect on growth. These findings are in accordance with Rousseau and Wachtel (2009): they found no statistically significant correlation between growth and finance for regressions including the post 2000 period.

Our results are in contrast with the findings of (Aghion and Banerjee, 2005). Indeed they sustain that Ramey and Ramey (1995) found non significant negative effect of volatility on growth because they did not control for financial development; our results do not confirm their view. In fact, our estimates show that a strong negative effect of volatility

still hold controlling or not for finacial development. Moreover financial deepening does not reduce the negative effect of volatility on growth,by contrast it tends to increase it. So we explain the nonsignificant results of by the fact that , they used a wrong measure of output volatility, indeed standard deviation as a measure of volatility is weak because it does not take into account growth differences accross countries and it is endogenous to growth. Finally they do not account for cross-section dependence. Therefore all these limilitations could have been conduct to some distortions in the estimates. To sum up our findings could be summarized as follows: There exists a long run relationship between output growth and the other control variables, ignoring this issue can lead to misleading inferences or inconsistent estimators. We also found that the non stationarity of the panel is attribute to the presence of common factors. Our results confirm the Ramey and Ramey (1995) findings. Indeed they showed that there exist a negative relationship between real growth and volatility, but they failed to demonstrate a strong negative relationship for OECD countries. Finally, financial development tend to reduce macroeconomic volatility, but does not dampens its effect on growth.

4 Concluding remarks

In our analysis we tried to fill the gaps in the literature on output growth-volatility tradeoff. In that aim we adopted modern nonstationary panel data approach using a data set of 85 countries and a subsample of 24 OECD countries from 1975-2006, we estimate the output growth volatility-relationship allowing for cross section dependence. Our analysis consists of different steps. First we test cross-section dependence through two unit root tests. Then, we check wether there exists a long run relation among the variables. Then, we estimate the long-run relationship using (eberhardt, 2013) estimators approach. We firstly make the Ramey and Ramey (1995) regression, then we add private credit to account for financial development. Finally we split the sample in two subperiods in order to check if the impact of financial development change over the time. We detected the presence of cross-section dependence and nonstationarity among the variables. The cointegration test show the existence of long run relationship among the variables of the panel. The AMG estimates confirmed the findings of Ramey and Ramey (1995), and showed a negative relationship between output growth and volatility for OECD countries.

Thus, cross-section dependence must be taken into account in the analysis of the relationship between output growth and volatility, because leaving it out could lead to important distortions. Our study shows that macroeconomic fluctuations hamper growth for both the whole sample and the subsample of developed countries. Moreover we find that the financial development is not a shield against the negative effect of volatility on economic growth. Our results are in line with the more recent litterature on growth, which suggests vanishing effects of finance on growth. It states that the marginal effects of finance become negative when the private credit approach the threshold of 100%

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